Rec'd PCT/PTO 25 JAN 2005 #2

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REC'D 22 SEP 2003
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CERTIFICATE

This certificate is issued in support of an application for Patent registration in a country outside New Zealand pursuant to the Patents Act 1953 and the Regulations thereunder.

I hereby certify that annexed is a true copy of the Complete Specification as filed on 9 August 2002 with an application for Letters Patent number 520687 made byWellington Survey Laboratory Limited.

I further certify that pursuant to a claim under Section 24(1) of the Patents Act 1953, a direction was given that the application proceed in the name of SURVEYLAB GROUP LIMITED.

Dated 28 August 2003.

PRIORITY DOCUMENT
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520687

SUBSTITUTION OF APPLICANT
UNDER SECTION 24

NEW ZEALAND

PATENTS ACT, 1953

INTELLECTUAL PROPERTY
OFFICE OF N.Z
09 AUG 2002
RECEIVED

COMPLETE SPECIFICATION

INSTRUMENT INCORPORATING A CAMERA AND DISTANCE METER

We, WELLINGTON SURVEY LABORATORY LIMITED a New Zealand company of 73 Rugby Street, Newtown, Wellington, New Zealand, do hereby declare this invention to be described in the following statement:

FIELD OF INVENTION

The invention comprises a mobile instrument including at least a camera and distance meter, and which may also include a compass and/or GPS receiver.

BACKGROUND OF INVENTION

Instruments are known which combine a digital camera and distance meter or range finder such as a laser range finder, and which are intended to be hand held or tripod or monopod mounted in use. Such instruments may also be associated with a GPS receiver and a compass, in order to record when an image of a subject is taken by the camera, the position of the camera or person operating the camera, the direction in which the camera is aimed, the distance to the subject or target, and the inclination to the subject or target. See for example www.mdl.co.uk.

SUMMARY OF INVENTION

It is an object of the invention to provide a mobile instrument for survey or similar purposes which combines a camera and distance meter and optionally at least also an electronic compass and GPS receiver, which is convenient to use.

In broad terms the invention comprises a mobile instrument including:

camera and distance meter modules mounted within a body of the instrument,

a mirror pivotally mounted within the body of the instrument and towards which the camera and distance meter are directed, and

adjustment means enabling a user to pivotally move the mirror to alter the aim angle of the camera and distance meter from the instrument together, without moving the body of the instrument.

In a preferred form the adjustment means includes an adjustment wheel, a peripheral portion of which is exposed through an aperture in the body of the instrument.

In a preferred form the mobile instrument includes an electronic compass arranged to indicate to a central processing and data recording system of the instrument the compass direction in which the camera and distance meter are aimed, a GPS receiver arranged to indicate to the central processing and data recording system the position of the instrument, and means such as a rotational angle meter arranged to indicate the angular position of the mirror comprises a rotational angle meter coupled to the axis of pivotal movement of the mirror to indicate the angular position of the mirror.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described with reference to the accompanying figures which illustrate one form of instrument of the invention by way of example and without intending to be limiting. In the figures:

Figure 1 shows a preferred form instrument from the exterior.

Figure 2 shows use of the preferred form instrument by a user.

Figure 3 is a schematic cross-section through the preferred form instrument.

Figure 4 is a basic block diagram showing the major parts of the preferred form instrument.

Figure 5 schematically shows the camera and distance meter modules and aiming mirror within the body of the instrument from one side.

Figure 6 shows the camera and distance modules and aiming mirror in the direction of arrow A in Figure 5.

DETAILED DESCRIPTION OF PREFERRED FORM

Referring to Figures 1 and 4 the preferred form instrument combines digital camera, distance meter, electronic compass and GPS receiver modules as a single integrated unit intended to be hand held or tripod or monopod mounted in the field. The unit includes a central processing and data recording system which controls and integrates the functions of the modules of the instrument. In use when the instrument is aimed at a subject and an image taken the instrument as well as recording the digital image records the position of the instrument via the GPS receiver and the direction (azimuth and elevation) and distance from the instrument to the subject. When one or more images are subsequently downloaded from the instrument to be recorded or manipulated on a PC for example, associated with each image is a metafile of this data. Thus image processing or manipulation software such as ESRI's ArcGIS suite may calculate the position of the subject as well as having an image of the subject.

The subject may be a natural geographic feature, a manmade feature such as a building or pylon or similar, a tree etc, where it is desired to record an image and information on the subject for survey purposes. Alternatively the instrument may be used for recording a series of images at a crime or accident scene for example. The series of images taken by a user moving around the scene and the information associated with each image may be used to reconstruct a 3D virtual scene replicating the crime or accident scene or a part of the scene. Alternatively again the instrument may be used to record an image of cables or pipes or similar in the ground or in any other situation, before an access hole is filled in, and the metafile associated with the image will record the exact position of the cables or pipes.

The preferred form instrument comprises a body 1 which preferably houses the modules of the instrument as a single integrated unit. In the preferred form the body 1 also

mounts a PDA such as an iPAQ device, which receives and stores the metafile information associated with each image taken. The display of the PDA also displays the target towards which the instrument is directed and thus provides a viewfinder aim function, and settings of the instrument are controlled through the PDA. The PDA may be removed when the instrument is not in use.

Within the body 1 of the unit, mounted to a frame or similar within the interior of the unit are a camera and laser distance meter modules 30 and 31. The output laser of the distance meter 31 is directed towards a mirror 32 which is pivotally mounted within the body of the instrument as shown, so that the mirror directs the laser from the windowed aperture in the body of the instrument through which the laser and camera are directed. The camera 30 is also directed towards the mirror 32, so that a subject towards which the camera and laser distance meter are targeted will be recorded by the camera when an image is taken using the instrument.

To shift the aim of the instrument in a vertical plane it is not necessary for the whole instrument itself to be reoriented by the user. Typically where an instrument is hand held the user, looking through a view finder of the instrument, must tilt the whole instrument up or down as well as tilting the users head at the same time. In the instrument of the invention the mirror 32 is pivotally mounted and, adjustment means is provided enabling the user to pivotally move the mirror to alter the aim angle of the camera and distance meter from the instrument together, without moving the body of the instrument.

In the preferred form an adjustment wheel 33 is provided which is mechanically coupled to an axle 34 pivotally mounting the mirror, and a peripheral portion of the adjustment wheel 33 is exposed through an aperture 35 in the body of the instrument. The adjustment wheel is positioned so that it can be moved by a thumb of a user holding the instrument in two hands. In use the instrument is held vertically on a monopod 4 as shown in Figures 1 and 2 for example, and adjustments in the aim of the instrument in

the vertical plane can be made by adjusting the position of the mirror 32 via the thumb wheel 33.

In an alternative form instead of being directly coupled to the mirror axis 34 the thumb wheel or other form of adjuster may be coupled via a gear or gears to provide finer adjustment for example. Alternatively the angular position of the mirror may be varied by an electric motor coupled to the mirror 32 or a mounting system for the mirror, which is in turn controlled via a thumb wheel or any other suitable control means such as an up-down rocker button or similar.

The coupling between the adjustment wheel and the mirror may optionally include a slip clutch arrangement so that when the mirror reaches its stop the adjustment wheel may still move, but provide tactile feedback to the user that the mirror has stopped moving.

The preferred form instrument also incorporates an electronic compass 36 and a GPS receiver 37 which may include a GPS dome 37a in the top of the body of the instrument, and a central processing and data recording system which records the position of the instrument and direction and distance to the subject when an image is taken. A rotation angle meter 38 is coupled to the mirror axis 34 to indicate to the control system the angular position of the mirror relative to a known reference plane.

While the preferred form instrument combines a camera, distance meter, electronic compass, and GPS receiver, in a simpler form the instrument may combine simply a camera and distance meter. The mirror 32 is used to deflect the aim of the camera and laser distance meter towards the subject.

When the instrument also includes an electronic compass unit, the invention allows the compass to be kept in the horizontal plane. A magnetic field sensor measures the magnetic field strength in a particular plane, and if one sensor is used to measure the earth's magnetic field, then the compass must be kept precisely in the horizontal plane. If the sensor is tilted then the amount of indicated magnetic field is altered the amount

will depend in the position of the earth, as the vector direction magnetic field changes over the globe, (vertical at the magnetic poles, horizontal in-between them). The component of the earths magnetic field useful for navigation purposes is the projection of the vector onto the plane tangent to the earths surface. However by combining the 3 magnetic field sensors and the 2 inclinometers, a tilt compensated compass bearing can be found. To automatically account for the tilt of the compass, and the varying slope of the magnetic field, three magnetic field sensors maybe arranged to measure in the x, y and z direction, thereby finding the direction in space of the magnetic field sensor. The compass platform's deviation from level is found by a pair of inclination sensors aligned with the compass x and y sensors. An example of such a compass is AOSI's EZ-Tilt 3, http://www.aositilt.com/Compass.htm.

However the invention is still useful as a real three sensor electronic sensor still has best performance when horizontal or near horizontal. All the other sensors just compensate for tilt, so if their input can be reduced, by constraining the allowable tilt, then the compass will perform better. Also, tilt sensors provide best results around a certain point, usually associated with level, their output quality degrades as the angle increases.

In summary in the instrument of the invention the camera and distance meter are aligned so that they point in the same direction, and vertical angle deflection is achieved by rotating the mirror on the mirror axle axis. The change of vertical deflection is twice the mirror angle by virtue of the laws of reflection.

The geometry of the device must allow for the mirror to fully reflect the views of the distance meter and camera for all mirror angles.

Viewfinder aim function maybe achieved by looking at the output of the digital camera on the control computer.

The digital camera can provide a fast succession of images, allowing real-time viewing of the target to the control computer screen. It can also capture a single frame for the

computer. The digital picture, being precisely aligned and calibrated with the other sensors, has the same attributes as the laser distance meter - azimuth bearing, inclination, GPS position. As the camera is viewing the subject through a mirror, the output picture will be reversed in one axis. In the configuration shown, it is top – bottom reversed. This can be corrected in the camera, or in the control software.

The mirror angle meter measures the angle of the mirror with respect to the frame. The angle meter maybe set up so that it outputs an angle of zero degrees when the output beam is horizontal, and the mounting frame is plumb. The deflected angle will be twice mirror movement angle.

The compass, which is fixed to the frame, must be located so that any material that distorts the earths magnetic field has the least effect on the compass, or are fixed in place so that their impact may be minimised by the compass's internal hard and soft iron calibration routines.

The compass measures the earths magnetic field in the x, y and z axis, it also measures the compass platform deviation from plumb in the x and y axis. The tilt measurement combined with the three sensor compass measurement provides an accurate compass bearing even for a non-level compass board. The raw platform tilt measurements provide information for electronically levelling the device.

The GPS receiver measures the position of the instrument. The accuracy of the GPS receiver may be enhanced using differential systems. The reference of the GPS receiver is the phase centre of the GPS antenna.

The control computer is connected to all of the measurement devices and polls the sensors for data. It also displays an electronic viewfinder to facilitate aiming of the device.

When the device is aimed at the target, the 'measure' button is pressed and the control computer takes data from all the sensors

- Position of the Unit (GPS)
- Distance (Laser Distance Meter)
- Azimuth bearing (Electronic tilt compensated compass)
- Mirror Angle
- Platform tilt from plumb (Tilt sensors on compass)
- Digital picture of target
- Time / date of measurement

These measurements, along with calibration coefficients from manufacture, are processed to provide the location of the target, and a picture. The processed data, and if required the raw data, is stored in the control computers memory, possibly in a GIS database.

Optionally the instrument maybe arranged to take a series of images or video of a subject, and record the data for the video segment or for each frame of the image series.

The instrument may also be configured to record audio information via a microphone, such as a sound byte or audio annotation from the user, to accompany the image or images and metafile information.

The instrument may also include a port for connection of another external device from which the instrument may obtain further information and append additional information to the metafile information associated with each image or image series.

The foregoing describes the invention including preferred forms thereof. Alterations and modifications as will be obvious to those skilled in the art are intended to be incorporated in the scope hereof as defined in the following claims.

CLAIMS:

1. A mobile instrument including:

camera and distance meter modules mounted within a body of the instrument,

a mirror pivotally mounted within the body of the instrument and towards which the camera and distance meter are directed, and

adjustment means enabling a user to pivotally move the mirror to alter the aim angle of the camera and distance meter from the instrument together, without moving the body of the instrument.

2. A mobile instrument according to claim 1 wherein the adjustment means includes an adjustment wheel, a peripheral portion of which is exposed through an aperture in the body of the instrument.

3. A mobile instrument according to claim 1 or claim 2 wherein the adjustment means is mechanically coupled to the mirror.

4. A mobile instrument according to claim 2 wherein the adjustment wheel is coupled to the mirror through a slip clutch mechanism.

5. A mobile instrument according to claim 1 or claim 2 wherein the adjustment means includes an electric motor arranged to pivotally move the mirror.

6. A mobile instrument according to any one of claims 1 to 4 including means arranged to indicate the angular position of the mirror relative to a known reference plane associated with the instrument.

7. A mobile instrument according to claim 5 wherein the means arranged to indicate the angular position of the mirror comprises a rotational angle meter coupled to the axis of pivotal movement of the mirror to indicate the angular position of the mirror.

8. A mobile instrument according to any one of claims 1 to 7 wherein the instrument also includes an electronic compass.

9. A mobile instrument according to any one of claims 1 to 8 wherein the instrument also includes a GPS receiver.

10. A mobile instrument according to any one of claims 1 to 7 including an electronic compass arranged to indicate to a central processing and data recording system of the instrument the compass direction in which the camera and distance meter are aimed, and a GPS receiver arranged to indicate to the central processing and data recording system the position of the instrument.

WELLINGTON SURVEY LABORATORY LIMITED
By the authorised agents
A. J. PARK
Per

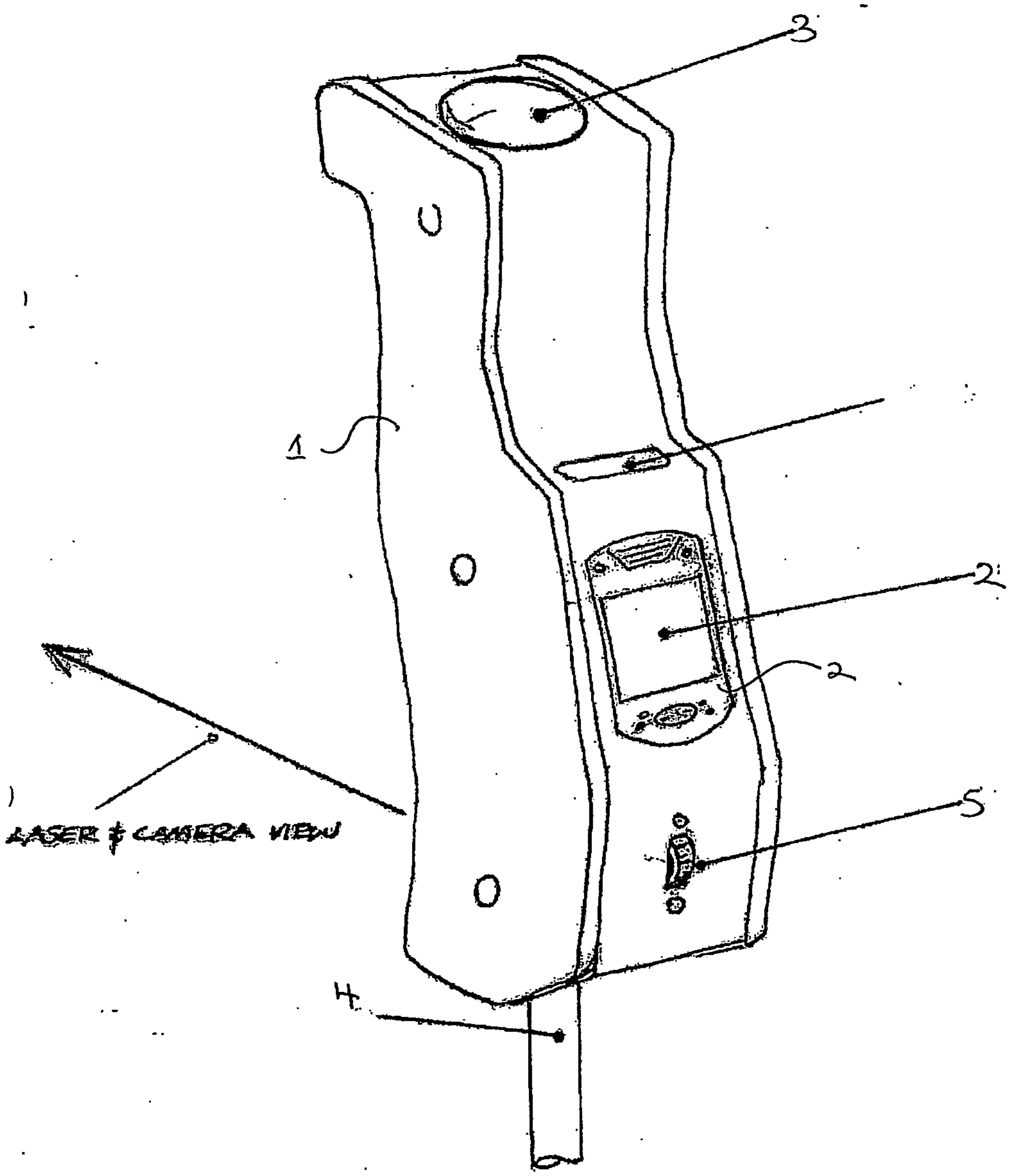

FIGURE 1

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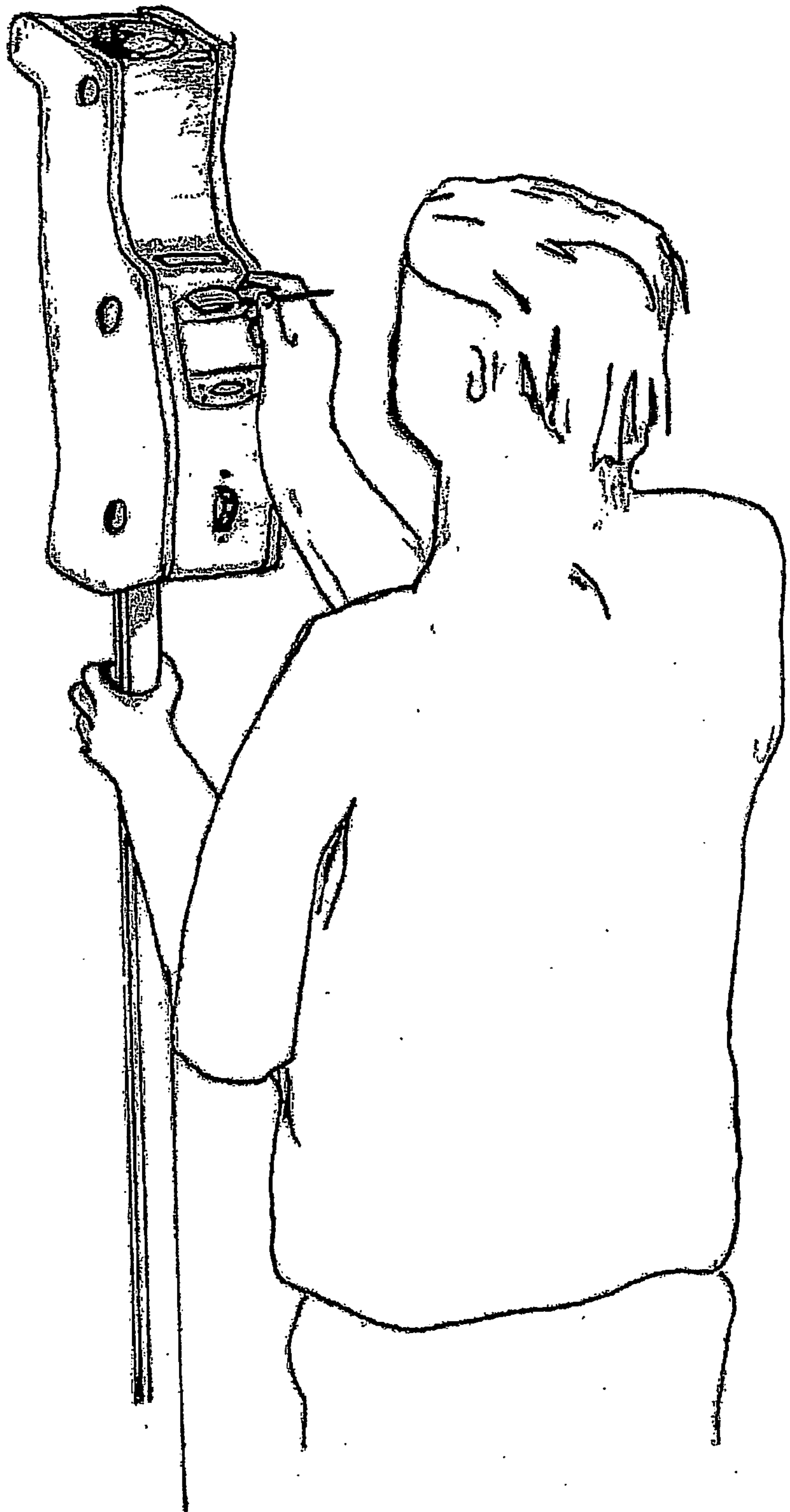

FIGURE 2

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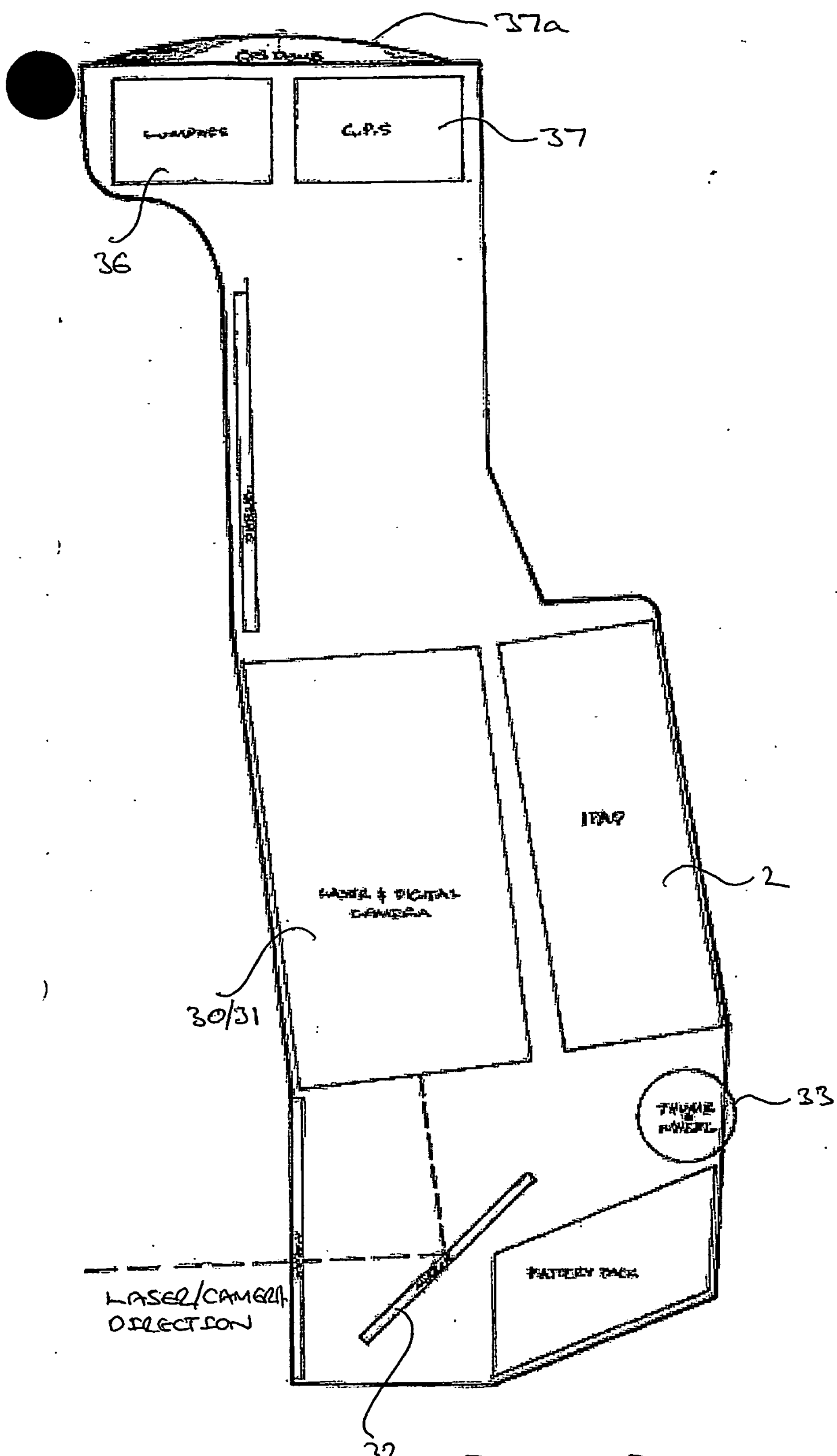

FIGURE 3

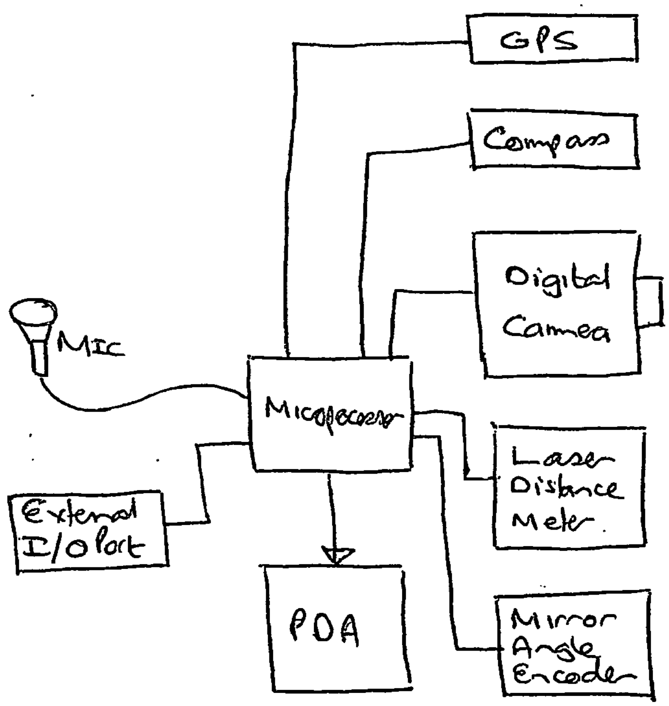
GPS
Compass
Digital Camera
Mic
Microprocessor
Laser Distance Meter
External I/O Port
PDA
Mirror Angle Encoder

Fig 4

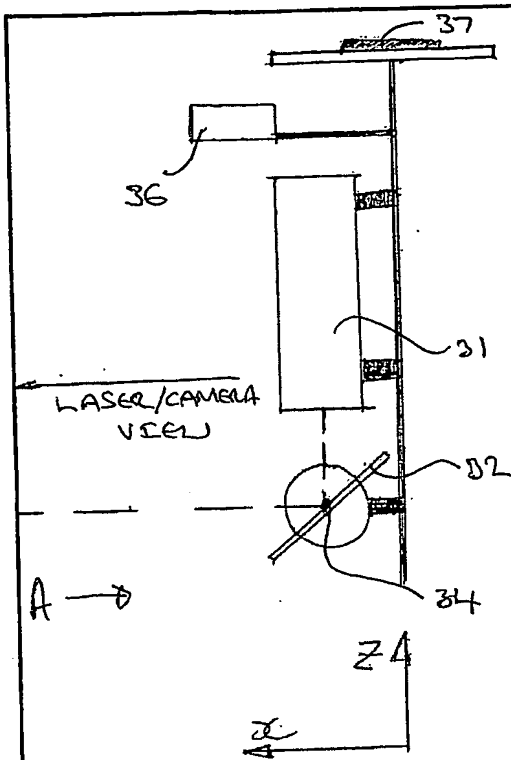

Figure 5

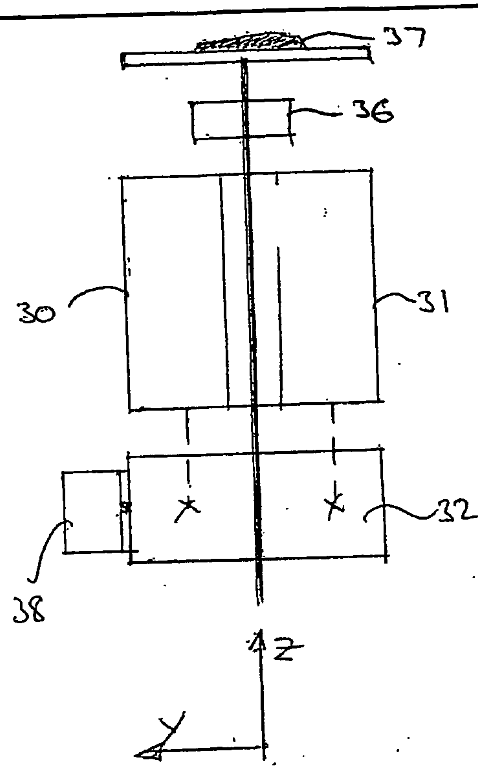

Figure 6